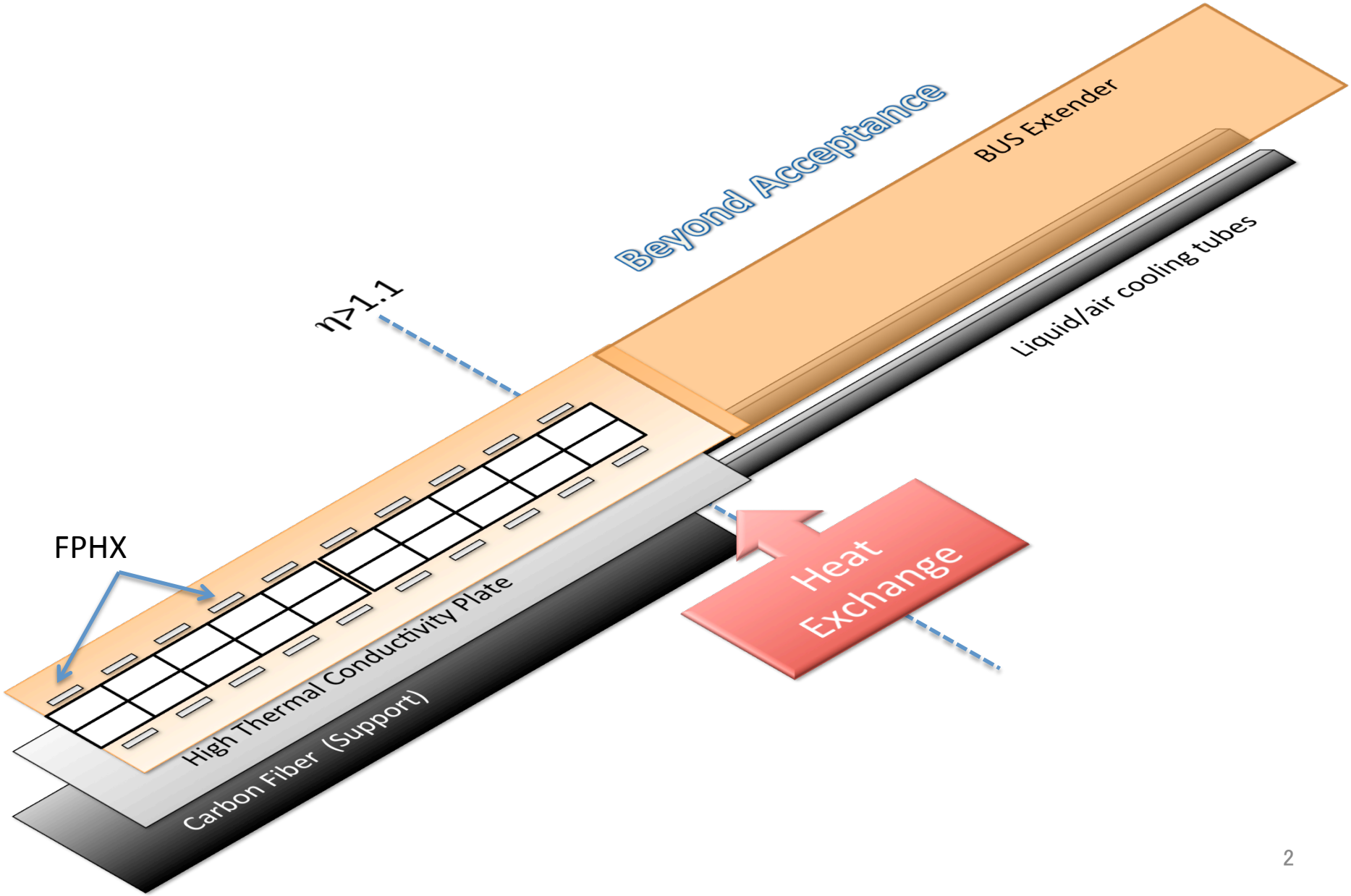
INTT Material Budget Plan

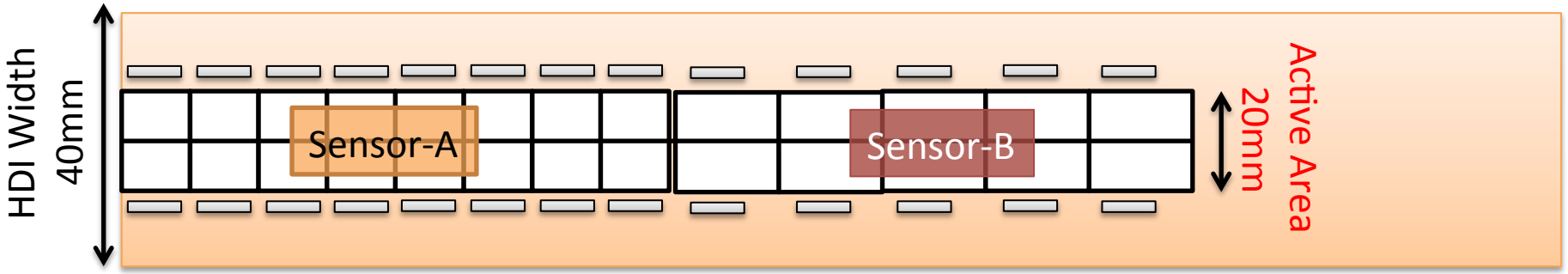
RIKEN/RBRC
Itaru Nakagawa

Ladder Structure

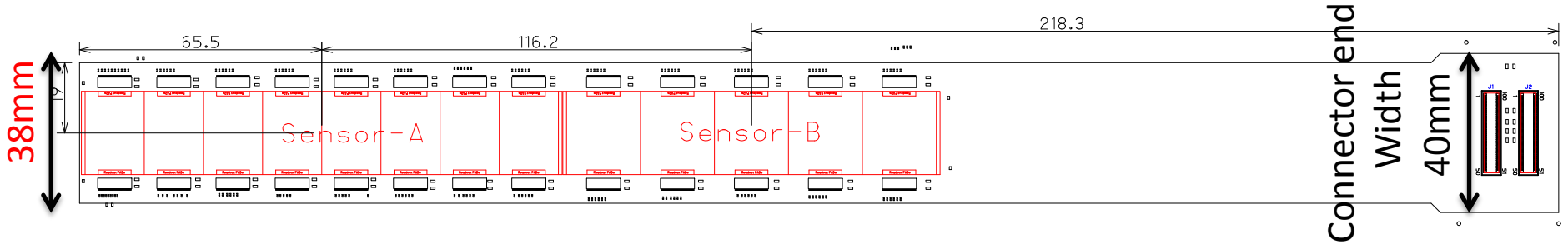


Silicon Module

- Present INTT GEANT Model

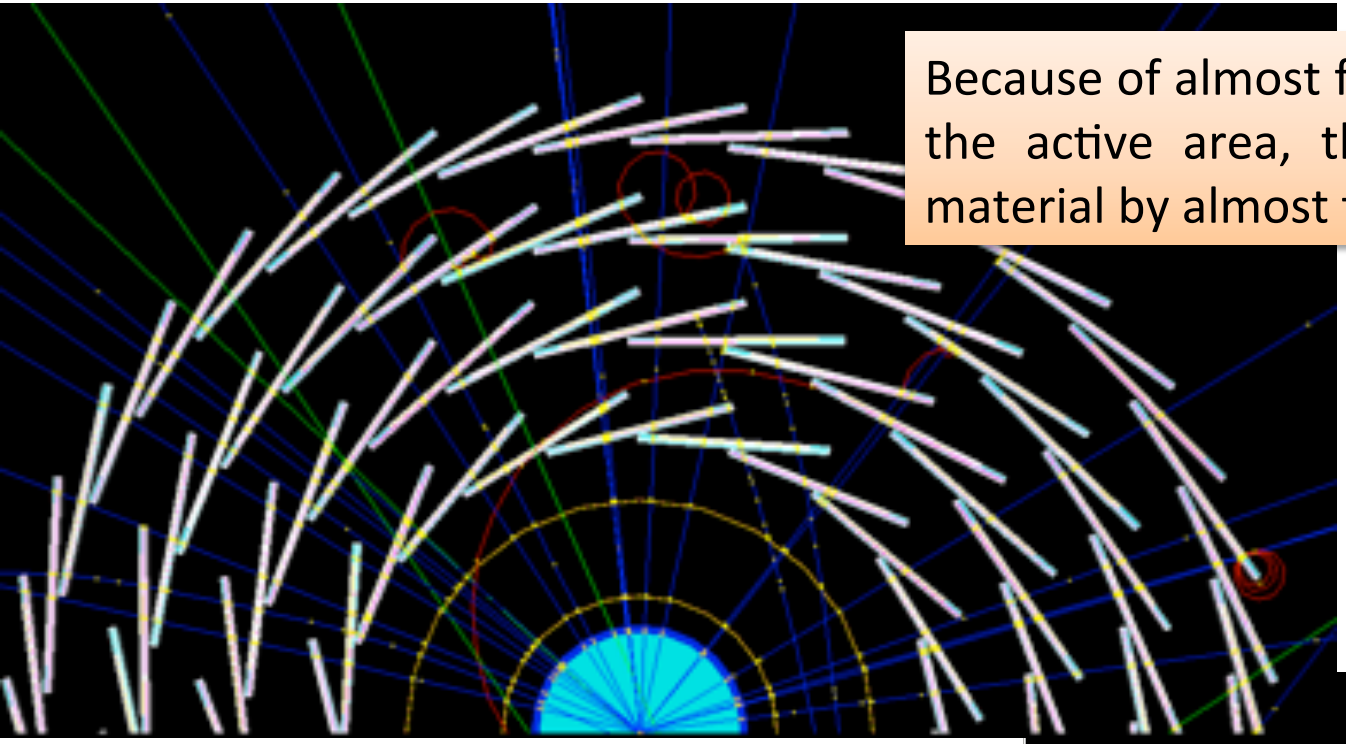


- Prototype Design

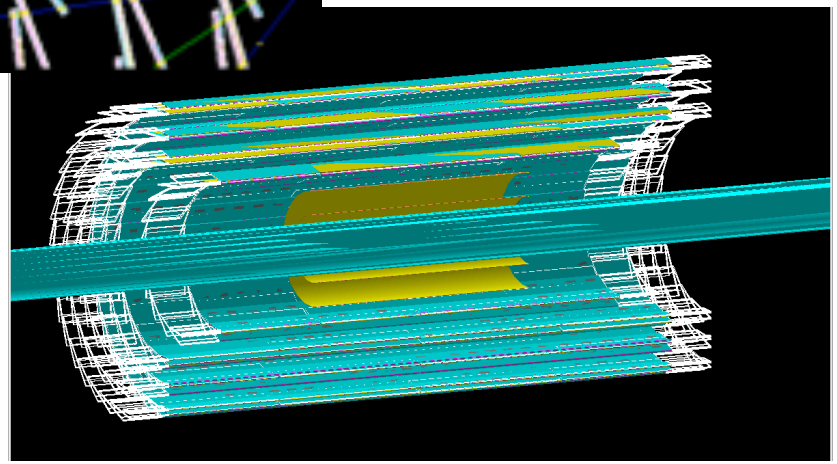


The 38mm is the technological limit width. It is unlikely this width becomes narrower in the future R&D.

INTT Barrel and Ladder Overlap



Because of almost factor of 2 wider HDI than the active area, the overlap adds up the material by almost factor of 2.

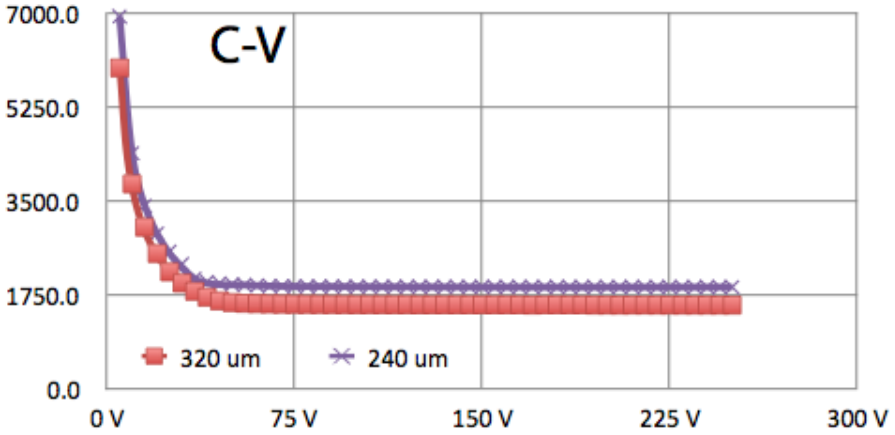


INTT Ladder Material Budget

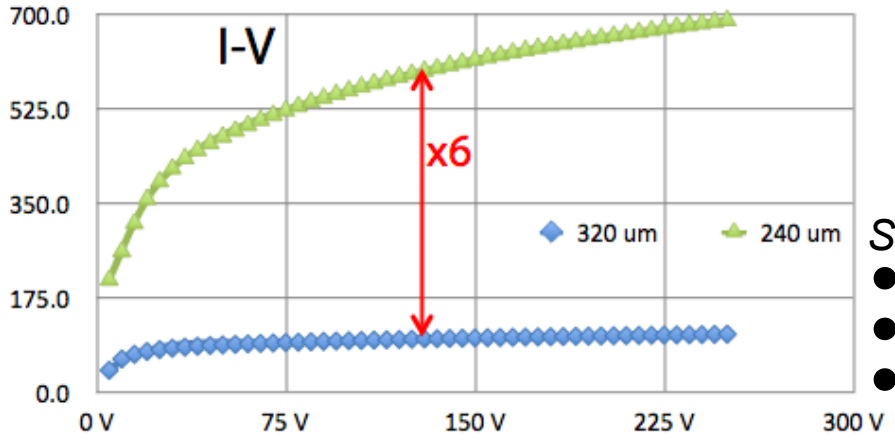
	Thickness	Radiation Length X/X_0	R & D Goal
Silicon	240 μm	0.3 %	0.25 ~ 0.3 %
HDI	< 500 μm	0.7 %	0.34 ~ 0.7%
High Thermal Conductivity Plate	350 μm	0.18 %	0.09? ~ 0.18 %
Carbon Fiber Support	230 μm	0.08 %	0.05? ~ 0.08%
Total		1.26 %	0.73? ~ 1.26%

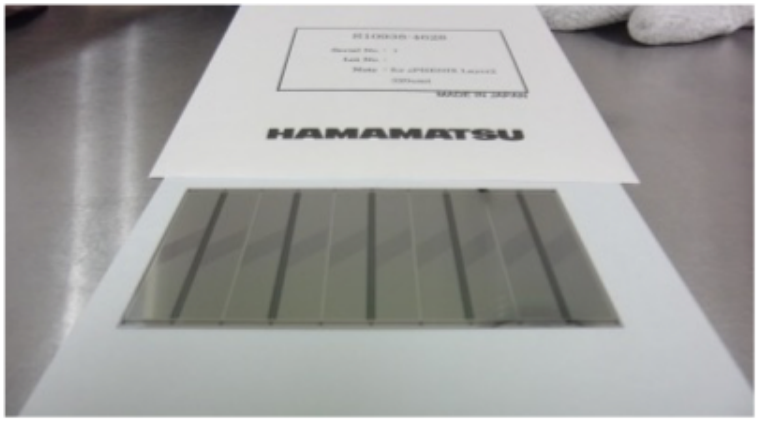
X/X0 is multiplied by 2 for overlapping ladder

Reducing Material (Silicon sensors)



Thickness	320 mm	240 mm
Full Depletion Voltage [V]	45	< 45





Thickness	200 µm	240 µm	320 µm
X0	0.21%	0.26%	0.34%
Dark current / 320µm	similar with 240µm	x6	x1
Price	> 0.5k USD?	0.4k USD	0.3k USD

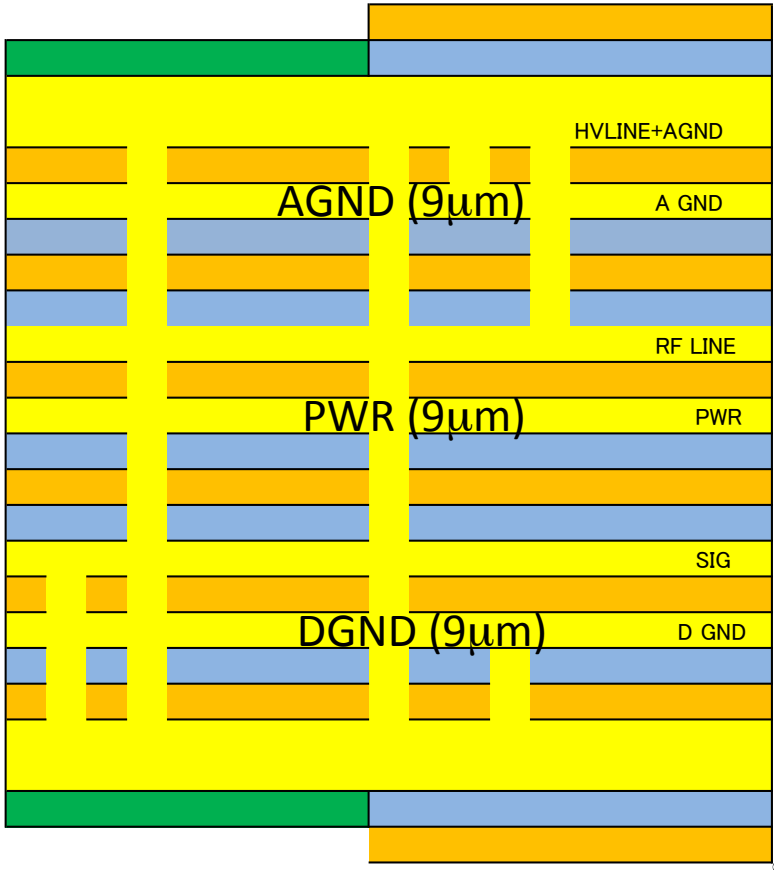
Silicon sensors for the strip layers

- Two thicknesses, 240 µm and 320 µm.
- 240 µm sensor is made by grinding 320 µm one.
- Hamamatsu says 200 µm is possible.
  → compromise with increasing dark current.

HDI Layer Structure

	Regist	20 μm
	Copper plated	15 μm
L1	Electrolytic copper foi	9 μm
	Base Polyimide	50 μm
L2	Electrolytic copper foi	9 μm
	Glue	15
	Coverlay Polymide	12.5 μm
	Glue	25 μm
L3	Electrolytic copper foi	9 μm
	Base Polyimide	50 μm
L4	Electrolytic copper foi	9 μm
	Glue	15 μm
	Coverlay Polymide	12.5 μm
	Glue	25 μm
L5	Electrolytic copper foi	9 μm
	Base Polyimide	25 μm
L6	Electrolytic copper foi	9 μm
	Bonding Sheet	25 μm
	Base Polyimide	50 μm
L7	Electrolytic copper foi	9 μm
	Copper plated	15 μm
	Regist	20 μm
		μm

438 μm



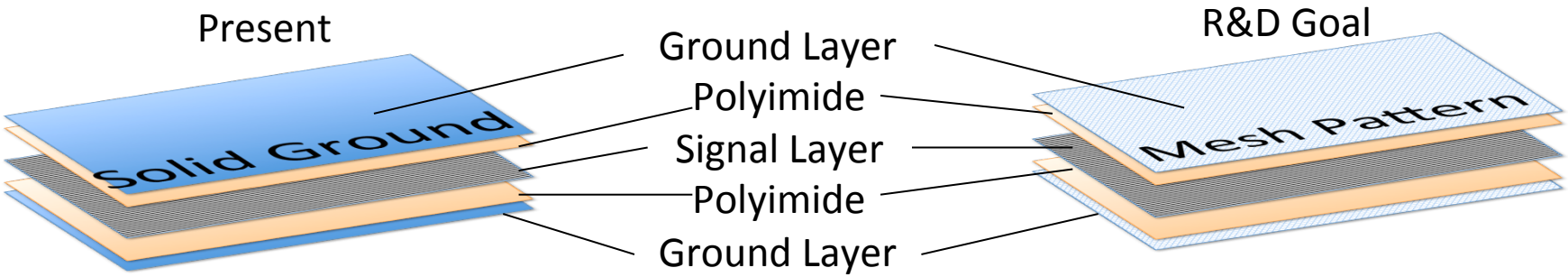
	Coverlay Polyimide	12.5 μm
	Coverlay Glue	25 μm
	Copper plated	15 μm
L1	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
L2	Electrolytic copper foil	9 μm
	Glue	15 μm
	Coverlay Polyimide	12.5 μm
	Glue	25 μm
L3	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
L4	Electrolytic copper foil	9 μm
	Glue	15 μm
	Coverlay Polyimide	12.5 μm
	Glue	25 μm
L5	Electrolytic copper foil	9 μm
	Base Polyimide	25 μm
L6	Electrolytic copper foil	9 μm
	Bonding Sheet	25 μm
	Base Polyimide	50 μm
L7	Electrolytic copper foil	9 μm
	Copper plated	15
	Coverlay Glue	25 μm
	Coverlay Polyimide	12.5 μm

TOTAL Thickness 473 μm

TOTAL Thickness

Material	X/X_0	R&D Goal
Polyimide Total	0.3 %	
Cupper Layer Total	0.4 %	

Reducing Material (HDI)



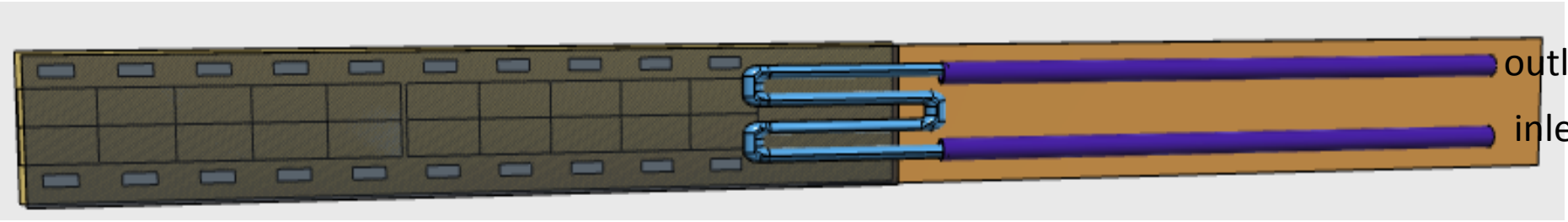
Signal layers are electrically shielded by sandwiched by solid ground layers

solid ground layers are meshed pattern so that to reduce material without loosing noise shielding performance. The goal is to reduce the Cu material by 10%. (Prototype is to be delivered in April)

Material	X/X_0	R&D Goal
Polyimide Total	0.3 %	
Cupper Layer Total	0.4 %	0.04 %

Reducing Material : High Thermal Conductivity Plate

- View from the back



High Thermal Conductivity Plate

Heat Exchange

Liquid/Air tubes

The point of high thermal conductivity plate is to transport the heat from the chip to the heat exchange. Carbon fiber support is not drawn here for visibility.

Cooling Option

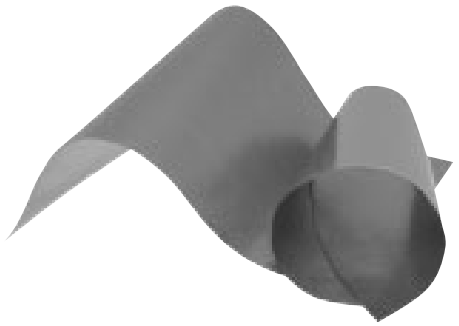
- In addition to air cooling option, the high thermal conductivity plate (sheet) will be tested. It has an advantage to make the cooling system even simpler and less material.

Panasonic "PGS" Graphite Sheets

"PGS" Graphite Sheets

Type: **EYG**

PGS (Pyrolytic Graphite Sheet) is a thermal interface material which is very thin, synthetically made, has high thermal conductivity, and is made from a higly oriented graphite polymer film. It is ideal for providing thermal management/heat-sinking in limited spaces or to provide supplemental heat-sinking in addition to conventional means. This material is flexible and can be cut into customizable shapes.



■ Characteristics

Characteristics		Specification	Specification	Specification
Thickness		0.10 ± 0.03 mm	0.07 ± 0.015 mm	0.025 ± 0.010 mm
Density		0.85 g/cm^3	1.1 g/cm^3	2.1 g/cm^3
Thermal conductivity	a-b plane	600 to 800 W/(m·K)	750 to 950 W/(m·K)	1500 to 1700 W/(m·K)
Electrical conductivity		10000 S/cm	10000 S/cm	20000 S/cm
Extensional strength		19.6 MPa	22.0 MPa	30.0 MPa
Expansion coefficient	a-b plane	9.3 × 10^{-7} 1/K	9.3 × 10^{-7} 1/K	9.3 × 10^{-7} 1/K
	c axis	3.2 × 10^{-5} 1/K	3.2 × 10^{-5} 1/K	3.2 × 10^{-5} 1/K
Heat resistance		400 °C		
Bending(angle 180,R5)		10000 cycles		

Design and specifications are each subject to change without notice. Ask factory for the current technical specifications before purchase and/or use.
Should a safety concern arise regarding this product, please be sure to contact us immediately.

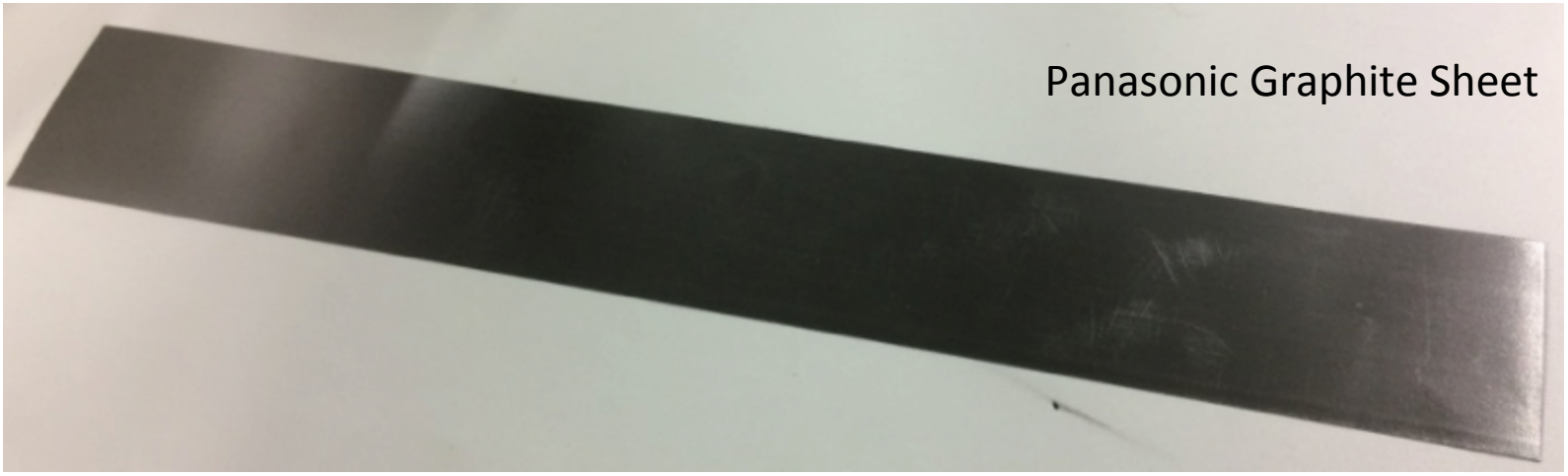
00 Sep. 2008

Some sample sheets are delivered.

Sample Graphite Sheets

- We have graphite sheets to be tested from 3 different companies.

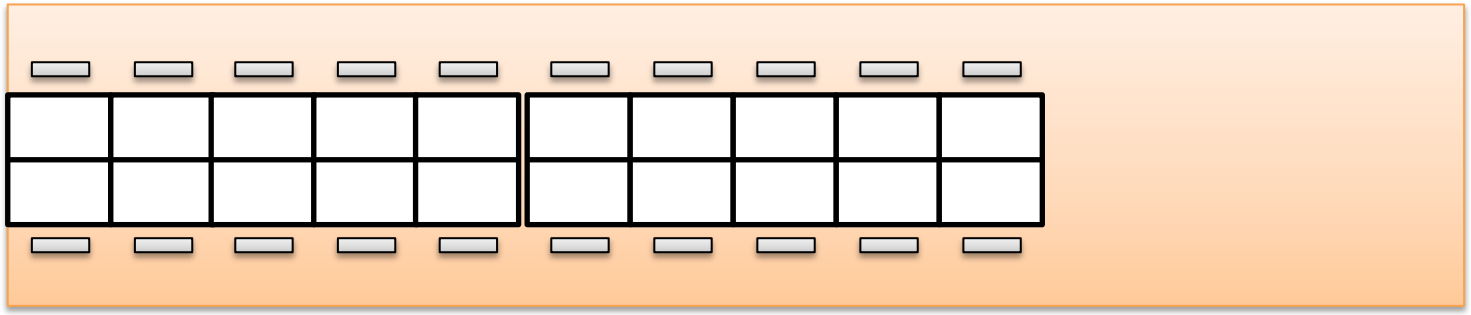
Make	**Panasonic**	**Kaneka**	**Blady**
Thickness [μm]	70	40	70
Thermal Conductivity [Wm/K]	1000	500	300 ~ 1500



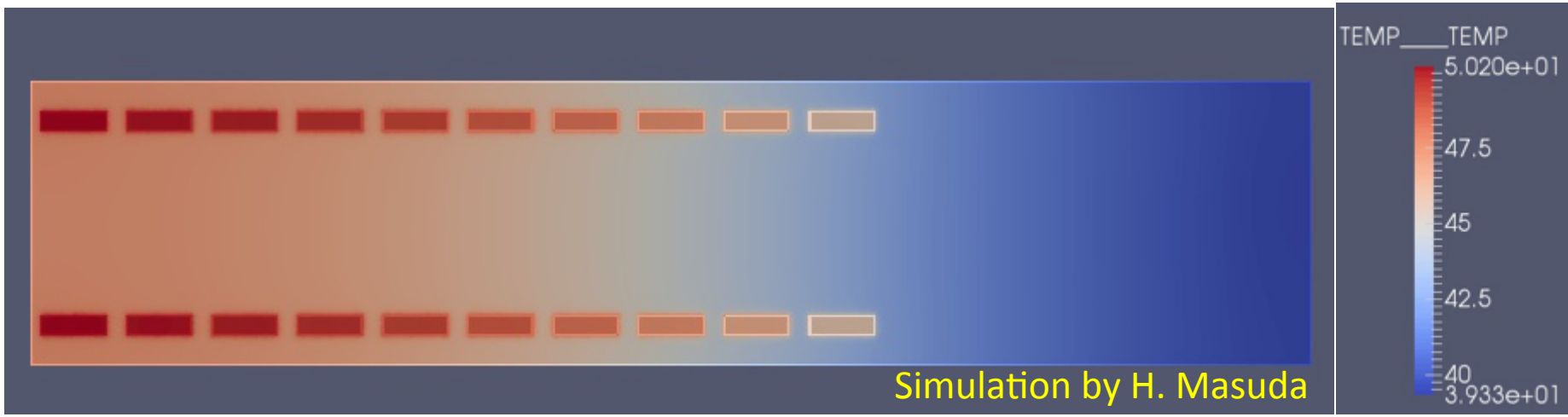
Dimension is made to be same with s0 HDIs (30cm x 4cm x 70 μm)

Cooling Simulation

Layer-0



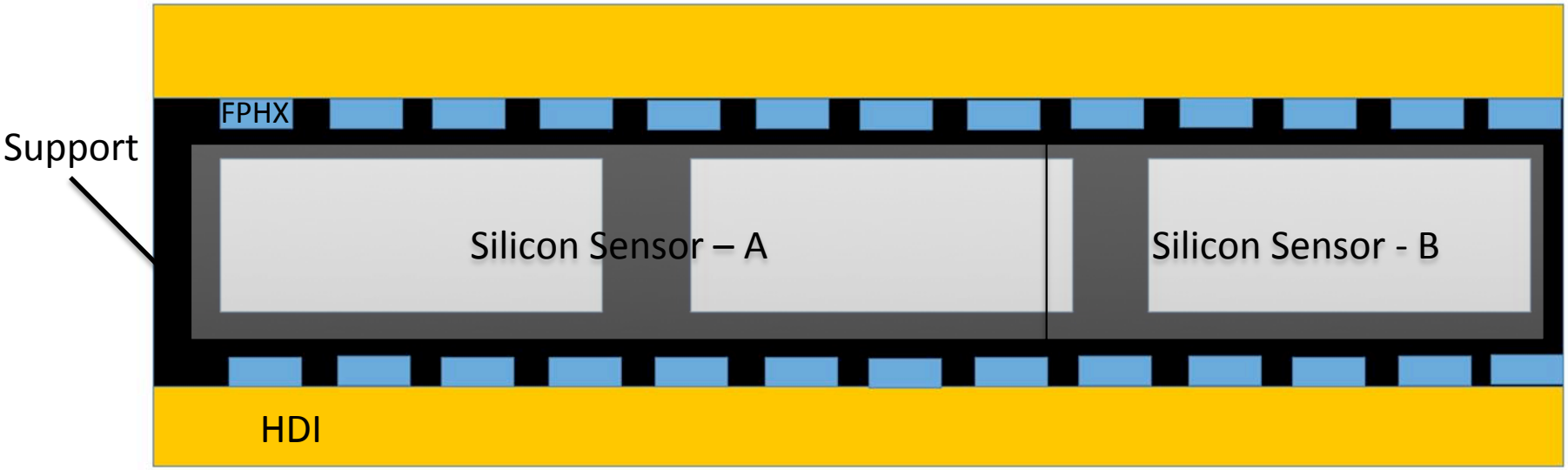
- Predicted by the Simulation (Salome-meca Developed by Electricite De France)



Condition: FPHX 65mW/chip, 70μm Graphite Sheet (1200W/mK), 100% longitudinal heat transfer is assumed. Still need a fine tuning.

Reducing Material : Support

- Do we need to backup entire silicon acceptance or can it be open behind silicon sensors?



To be studied with engineers.

Improving Reconstruction Algorithm

Work by Gaku Mitsuka

- Alan's code does Hough transform for all MAPS, INTT, TPC. (Ignores multiple scattering effect).
- Step-1 (by mid Feb.) Hough transform only for TPC. Tracklet reconstruction by TPC only.
- Step-2 (by mid. March) Develop the algorithm to start from inner TPC tracklet to find relevant hit in INTT and MAPS. Search window reflects the multiple scattering effect.

Summary

- Due to the technical limit of HDI width, the ladder overlap between ladder will adds up material by factor of 2.
- HDI width is 38mm and unlikely to be narrower in future R&D.
- R&Ds are in progress for each components of ladders.
- Algorithm is under development to improve the tracking which makes the tracker material less impactful to the momentum resolution by taking into account the multiple scattering effect in the hit search window.

BACKUP

Silicon Module with Liquid/Air cooling Design